

Glimpses of Nature. By Andrew Wilson. (London: Chatto and Windus, 1891.)

MR. WILSON does not profess to present in this book anything strictly new, or to give a full account of the various subjects with which he deals. Nevertheless, the volume may be of considerable value, for on all the groups of facts in which he is interested he is able to discourse brightly and pleasantly, and many of his short papers are well calculated to excite in the minds of intelligent readers a desire for more ample knowledge. The papers are reprinted from the *Illustrated London News*.

LETTERS TO THE EDITOR.

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The Fusing and Boiling Points of Compounds.

I HEREWITH send you the translation of a note just presented for me by M. Berthelot to the Paris Academy, as you may see in the *Comptes rendus*. I have added two illustrations and a few words in italics.

GUSTAVUS HINRICHS.

St. Louis, May 8.

Statement of the General Law determining the Fusing and Boiling Points of any Compound under any Pressure, as Simple Function of the Chemical Constitution of the same.
By Dr. Gustavus Hinrichs.

The atomic form of normal lineary compounds, such as the paraffins, alcohols, acids, is very nearly prismatic. All other serial compounds may be referred to these, either as isomerics or

The boiling-point t of a prismatic compound consists of two distinct functions, namely—

$$t = y_1 + y_2 \dots \dots \dots (1)$$

where

$$y_1 = k_1(\log a - \log a_1) \dots \dots \dots (2)$$

and

$$y_2 = k_2(\log a_2 - \log a)^2 \dots \dots \dots (3)$$

The symbols a_1 and a_2 represent certain definite values of the atomic weight a of the compound, while k_1 and k_2 are constants.

For every value of the atomic weight a greater than a_2 the formula (1) is limited to $t = y_1$, which, according to (2), represents the straight line which I call the logarithmic limit, the ordinate being the boiling-point t , the abscissa x , the logarithm of the atomic weight $x = \log a$. For values of a less than the above limit a_2 , the parabolic ordinate y_2 , determined by (3), must be added to y_1 , according to (1), in order to obtain the boiling-point.

Accordingly, the boiling-point curve of any homologous series of prismatic atom-form consists of a parabolic arc (3), tangent to the logarithmic limit (2), at the point determined by $a = a_2$. The constant k_1 determines the inclination of the logarithmic limit, and k_2 may be called the parameter of the parabolic branch.

All compounds derivable by terminal substitution from normal paraffins have a common logarithmic limit, determined by $k_1 = 583.75$ and $a_1 = 72.78$, the pressure being 760 mm. Every individual homologous series of this great family of compounds is completely determined by the special values of the two constants a_2 and k_2 . For example, the thirty-five normal paraffins C_nH_{2n+2} are determined by $a_2 = 201$, and the parameter $k_2 = 200^\circ$. For the monamines, the corresponding values are $a_2 = 278$, and $k_2 = 225^\circ$. I have determined these constants for all the important series. Furthermore, these values are themselves functions of the atom or radical which characterizes the head of the corresponding homologous series—that is, H for the paraffins, H_2N for monamines, &c.

If now the co-ordinate $z = \log p$, where p is the pressure of

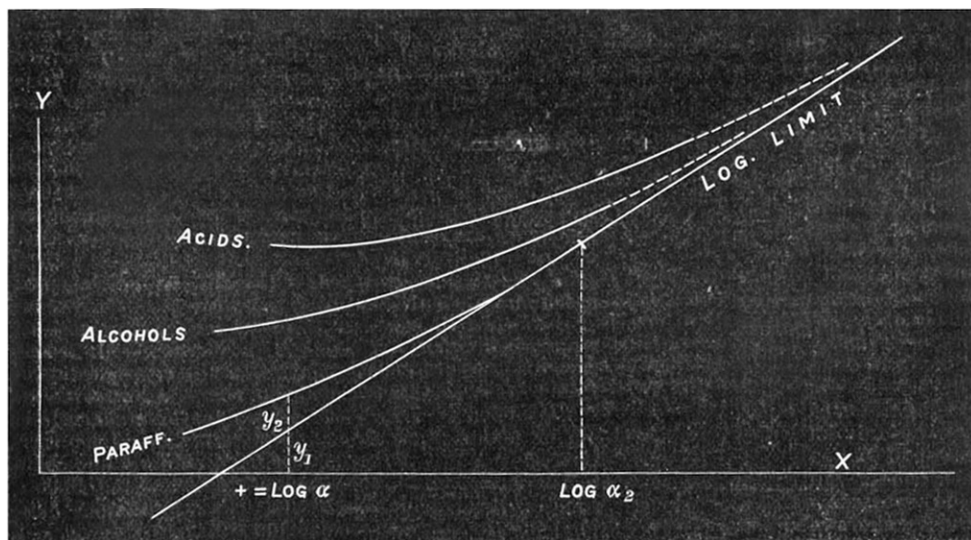


FIG. 1.

or substitution products. The boiling and fusing points of these latter are obtained from those of the former according to laws and processes published by me about twenty years ago, partly in my "Principles of Molecular Mechanics," 1874, and in Notes of the *Comptes rendus* for 1873 and 1875; partly in papers of the *Proceedings of the American Association for the Advancement of Science* for 1868. It remains, therefore, only to show how these fundamental points are determined for prismatic compounds.

the saturated vapours, be laid off on the third rectangular axis the above given values belong to the plane XY determined by $p = 760$ mm. For the pressure $p = 15$ mm. the logarithmic limit is determined by $k_1 = 517.0$, and $a_1 = 113.81$. It will be noticed that its inclination towards the X axis is less, and that it intersects the same at a greater distance from the origin. The logarithmic limit surface, generated by the logarithmic limits for all pressures, is a hyperbolic paraboloid, fully determined by the above two lines for 15 and 760 mm. pressure.

For any liquid, the absolute temperature T of the boiling under a pressure of p atmospheres is determined by the same general law slightly specialized as follows:—

$$T = Y_1 + Y_2 \dots \dots \dots (4)$$

where

$$Y_1 = K_1[1.4 + \log p] \dots \dots \dots (5)$$

and

$$Y_2 = K_2[\log \pi - \log p]^2 \dots \dots \dots (6)$$

The logarithmic limits of all liquids intersect in the same absolute zero point determined by $T = 0 = -273^\circ \text{C.}$ and $\log p = -1.4$. For each individual liquid this limit extends upwards to the critical point of the liquid, $p = \pi$ and $T = \theta$. For many liquids the critical point can be theoretically calculated, as well as the value of the parameter. It is understood

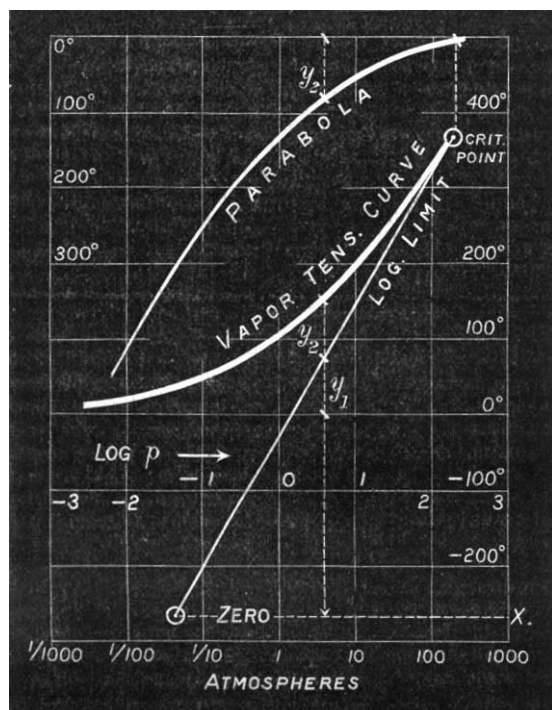


FIG. 2.

that the parabolic curve is tangent to the logarithmic limit at the critical point.

It hardly needs to be said that the tension of dissociation, and even the solubility of solids, are subject to the same general law.

The fusing points are obtained by simply changing the sign in (1) to

$$t = y_1 - y_2 \dots \dots \dots (7)$$

so that the parabolic curve will be placed below the logarithmic limit.

One of the most remarkable results of this research is the mechanical determination of the true position of the carbon atoms in organic serials, and the complete explanation of the difference in fusing point between compounds containing an even and odd number of carbon atoms.

It should also be understood that the change in fusing point produced by change in pressure is expressed by the same general law.

Putting $\log a = x$, $\log p = z$, and $\log \alpha = \xi$, $\log \pi = \zeta$, the formulæ (1) to (7) will become

$$t = y_1 \pm y_2, \quad y_1 = k_1(x - \xi), \quad y_2 = k_2(\xi - z)^2. \quad (8)$$

$$T = Y_1 + Y_2, \quad Y_1 = K_1(z - \xi), \quad Y_2 = K_2(\zeta - z)^2. \quad (9)$$

These formulæ strikingly show the simplicity of the laws stated, and also determine the surfaces formed by the co-ordinates x , t , and y in general.

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In subsequent notes special topics covered by this general law will be taken up, and the complete concordance of the law with the results of observations will be shown.

Porpoises in African Rivers.

IN reference to Mr. Slater's letter in NATURE of June 11 (p. 124), the following may be interesting to your readers:—

The skull of a Delphinoid Cetacean from Cameroon has lately come into my hands, through the kindness of Prof. Pechmel-Loesche. The sender, Mr. Edward Teusz, gave the following information concerning it. The animal to which it belonged was caught in Kriegschiff Bay, after very heavy rains, and was being devoured by sharks. The contents of the stomach consisted of grass, weeds, and mangrove fruits. None of the natives had ever seen the animal before. In preparing the skull, Mr. Edward Teusz noticed that the nostrils projected above the surface of the forehead.

I am preparing for publication a detailed description of the skull, and must here confine myself to remarking that, though the animal belongs to the genus *Sotalia*, it differs in several essential points from all the species of that genus hitherto described. I have no doubt that it is a new species. There are twenty-seven teeth on each side in each jaw. Their form, in that they are not pointed, but worn down, indicates, as also do the contents of the stomach, that the animal is herbivorous. It therefore seems certain that it is a fresh-water animal. It is well known that other *Sotalia* live in rivers.

Jena, June 20.

WILLY KÜKENTHAL.

PHYSICAL SCIENCE FOR ARTISTS.¹

I.

I THINK it right that I should begin by explaining how it is that I am here to-day, to lecture to you on a subject which touches art as well as science. It happens in this wise. Some years ago, while studying a certain branch of optics, it became important for me to try to learn something of the exact sequence of colours at sunrise and sunset; and being, like you, busy all day in a large city, I thought it would not be a bad idea, and that it would save a little time, if I studied pictures representing these phenomena *en attendant* the happy holiday time that I should spend in the country. So I went to the Academy and other picture galleries, and endeavoured to get up the information from pictures which I could not at that time get from Nature herself. I then had, as I have still, such an extreme respect for art and artists that I was perfectly prepared to take the pictures as representing truthfully what I wanted to see. The result, however, brought me face to face with a difficulty that I was not long in finding out. I was driven to the conclusion that artists could be divided into two distinct classes—those who studied Nature and Nature's laws, and gave us most exquisite renderings of this or that, and those who apparently considered themselves far superior to any such confining conditions as would be imposed by any law; and that, unfortunately, made me a little doubtful as to the results.

My friend, and your friend, Dr. Russell, happens to know this little bit of my experience, and hence it doubtless is that he requested me to come down to-day to say a few words to you, his plea being that this College is one of the very few institutions of its kind in the world where there is a studio and a physical laboratory side by side.

That, then, is the reason I am here, and what I want to impress upon you to-day is that the highest art can only be produced by those who associate the study of physical science with the study of art, and that therefore the possible producers of the highest art can only be looked for in such an institution as this if training of any kind has anything to do with it.

¹ A Lecture delivered at Bedford College, by J. Norman Lockyer F.R.S. on June 10, 1891.